

Harmful Cyanobacterial Bloom (HCB) Action Plan

for Publicly Accessible Lakes and Reservoirs of Wyoming



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Summary

This Action Plan is intended to provide the Wyoming Department of Environmental Quality (WDEQ), Wyoming Department of Health (WDH), Wyoming Livestock Board (WLB), resource management agencies and other cooperators with procedural guidelines should a harmful cyanobacterial bloom (HCB) be suspected in publicly accessible lakes or reservoirs in the State of Wyoming. Guidelines include: steps for evaluating whether a bloom is likely to contain harmful cyanobacteria; procedures to test for harmful levels of cyanobacteria and cyanotoxins; cyanobacteria cell density and cyanotoxin thresholds for issuing public health advisories; and procedures for lifting public health advisories. The plan also outlines the notification process should a HCB be identified in a public drinking water supply. Publicly accessible lakes and reservoirs used for primary contact recreation are the focus of this plan since contact, accidental ingestion and inhalation of cyanotoxins or other cyanobacteria-related irritants are most likely to occur in these waterbodies. This plan will be updated as new information becomes available.

For resources and more information on HCBs in Wyoming, including signage, outreach materials and issued advisories, visit WDEQ's webpage at WyoHCBs.org.

Table A. General strategy for HCBs in publicly accessible lakes and reservoirs of Wyoming.

Evaluation	Responsive Action
<p>Step 1: Observation and Reporting</p>	<ul style="list-style-type: none"> WDEQ, WDH and WLB will issue a press release at the beginning of the HCB season to remind the public of the health risks associated with HCBs as well as how to identify and report HCBs. WDEQ and/or cooperators should visually inspect publicly accessible lakes and reservoirs during the primary recreation season (see WyoHCBs.org for photos of Wyoming HCBs). WDEQ will also use satellite imagery, if available, to monitor lakes and reservoirs for HCBs. In the event of a bloom or a suspected HCB, report to WDEQ using the <i>Report a Spill</i> hotline at WyoSpills.org or (307) 777-7501.
<p>Step 2: Optional Preliminary Screening</p>	<ul style="list-style-type: none"> WDEQ or a cooperator can use optional jar and/or stick tests¹ to determine if cyanobacteria are present in a bloom or field test strips to determine if cyanotoxins are present. If tests are indicative of cyanobacteria or cyanotoxins, or the waterbody is known to have had HCBs in the past¹, the resource management agency may choose to place a HCB sign at the water body to inform recreationalists of potential health risks if a permanent HCB sign is not already in place. If field test strips indicate that cyanotoxins are present in reservoirs with a drinking water intake, cooperators should notify WDEQ. WDEQ will then notify the public water supply and EPA².
<p>Step 3: Sample Collection, Analysis and Issuing Advisories</p>	<ul style="list-style-type: none"> WDEQ or a cooperator should collect four water samples¹ for laboratory analyses: (1) one sample for cyanobacteria identification and enumeration; (2) one sample for microcystin and cylindrospermopsin analysis; (3) one sample for anatoxin-a analysis; (4) and one sample for saxitoxin analysis. Samples should be collected and shipped per WDEQ Standard Operating Procedures¹. If analyses indicate cyanobacteria densities $\geq 20,000$ cells/mL, total microcystin concentrations ≥ 8 µg/L or cylindrospermopsin concentrations ≥ 15 µg/L, WDEQ will notify WDH and WDH will issue an advisory. WDH will determine whether concentrations of anatoxin-a, saxitoxin or other conditions warrant issuance of an advisory. When an advisory is issued, WDH will inform the resource management agency and local health authorities. WDEQ will notify local county coordinators. WDH will coordinate posting of signs by the resource management agency, local health authorities and/or local county coordinators if a permanent HCB sign is not already in place. WDEQ will add the lake or reservoir to the list of current advisories on the WyoHCBs.org webmap. Due to potential impacts to migratory birds, fisheries and other wildlife, WDEQ will notify USFWS and WGFD when an advisory has been issued. If cyanotoxin levels exceed drinking water thresholds in water bodies that may impact drinking water supplies, WDEQ will notify the public water supply and EPA².
<p>Step 4: Monitoring and Lifting Advisories</p>	<ul style="list-style-type: none"> All advisories will remain in place until either (1) a bloom has fully dissipated and cyanotoxin concentrations are below the threshold values or (2) the primary contact recreation season ends on September 30th. For an advisory to be lifted prior to September 30th, WDEQ will determine if the bloom has fully dissipated based on visual evidence and satellite imagery, if available. Once cyanotoxin samples confirm safe concentrations, WDEQ will report results to WDH and WDH will lift the advisory. On September 30th, WDH, WDEQ and WLB will issue a press release and listserv notice describing that (1) any remaining advisory have been lifted, (2) WDEQ is no longer monitoring for HCBs, (3) HCBs may continue to be present in Wyoming surface waters in the cooler months, and (4) recreationists should continue to avoid HCBs due to the potential health risks. Once WDH has lifted an advisory, any temporary HCB signs may be removed by the resource management agency, local health authorities and/or local county coordinators. WDEQ will remove the lake or reservoir from the list of current advisories on the WyoHCBs.org webmap. WDH may issue a closure at any time during the process based on the threat to public health.

Abbreviations: EPA, US Environmental Protection Agency; WDEQ, Wyoming Department of Environmental Quality; WDH, Wyoming Department of Health; WGFD, Wyoming Game and Fish Department; WLSB, Wyoming Livestock Board; USFWS, United States Fish and Wildlife Service.

¹ See WyoHCBs.org for resources for management agencies, including signs, sampling procedures, information on publicly accessible lakes and reservoirs (e.g., contact information, past HCB occurrence, use as a public water supply, etc.).

² EPA implements the Safe Drinking Water Act in the State of Wyoming.

Table B. Cyanotoxin and cyanobacteria cell density thresholds for a recreational use.

Threshold	Threshold Values	Responsive Action
Recreation	$\geq 8 \mu\text{g/L}$ total microcystins ^{1,2} $\geq 15 \mu\text{g/L}$ cylindrospermopsin ^{1,2} $\geq 20,000$ cells/mL cyanobacteria Other cyanotoxins or conditions determined by WDH	Advisory
WDH determines there is sufficient threat to public health to restrict use of an impacted area or an entire reservoir.		Closure

Abbreviations: WDH, Wyoming Department of Health; $\mu\text{g/L}$, micrograms per liter; cells/mL, cells per milliliter.

¹ Cyanotoxin thresholds ($\mu\text{g/L}$) represent total concentrations of all congeners.

² Based on US Environmental Protection Agency [Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin](#).

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Definitions

Anatoxin-a	A cyanotoxin that primarily affects the central nervous system. Common cyanobacteria in Wyoming that produces anatoxin-a are <i>Anabaena</i> , <i>Aphanizomenon</i> , <i>Cylindrospermopsis</i> , <i>Microcystis</i> and <i>Phormidium</i> .
Benthic Cyanobacteria	Cyanobacteria that attach to rocks, sediment and macrophytes located on the bottom of a waterbody.
Cooperator	An entity or agency working jointly with the Wyoming Department of Environmental Quality, Wyoming Department of Health and Wyoming Livestock Board to achieve Action Plan objectives.
Cyanobacteria	A phylum of bacteria that obtain their energy from photosynthesis. Cyanobacteria are often referred to as <i>blue-green algae</i> , however they are taxonomically distinct from true algae. Cyanobacteria are commonly found in phytoplankton communities, but can also colonize benthic substrates and macrophytes.
Cyanotoxins	Toxins produced by cyanobacteria. Contact, ingestion and inhalation of these toxins can cause serious health impacts to humans, pets, livestock, wildlife and aquatic life.
Cylindrospermopsin	A cyanotoxin that primarily affects the liver. Common cyanobacteria in Wyoming that produce cylindrospermopsin are <i>Anabaena</i> , <i>Aphanizomenon</i> , <i>Cylindrospermopsis</i> and <i>Lyngbya</i> .
Harmful Cyanobacterial Bloom (HCB)	A highly dense concentration of cyanobacteria where there is an elevated risk to human or animal health due to cyanotoxin production or other cyanobacteria-related effects. Previously referred to as a <i>harmful algal bloom</i> or <i>HAB</i> .
Local County Coordinators	Local government coordinators responsible for preparing and protecting the public against problems that occur within their county.
Microcystin	A cyanotoxin that primarily affects the liver. Microcystin is a common toxin (more than 100 congeners) with the most widely available toxicological data. Common cyanobacteria in Wyoming that produce microcystin are <i>Anabaena</i> , <i>Aphanizomenon</i> , <i>Aphanocapsa</i> , <i>Gloeotrichia</i> , <i>Microcystis</i> , and <i>Pseudanabaena</i> .
Phytoplankton	Small photosynthetic organisms suspended in the water column. Phytoplankton communities commonly include cyanobacteria and algae.

Publicly Accessible Lakes or Reservoirs	Those lakes and reservoirs occurring on public or private land that can be used, entered and reached by the public without the permission of the land owner or land management agency.
Primary Contact Recreation	Recreational or other surface water use that could be expected to result in incidental ingestion of the water or immersion (full body contact).
Primary Recreation Season	Summer recreation season from May 1 st through September 30 th .
Resource Management Agency	Agency that manages a publicly accessible lake or reservoir, such as the Wyoming Game and Fish Department, Wyoming State Parks, United States Forest Service, Bureau of Land Management, Bureau of Reclamation and the United States Fish and Wildlife Service.
Saxitoxin	A cyanotoxin that primarily affects the central nervous system. Common cyanobacteria in Wyoming that produce saxitoxin are <i>Anabaena</i> , <i>Aphanizomenon</i> , <i>Cylindrospermopsis</i> and <i>Lyngbya</i> .
Scum	A cyanobacterial bloom that densely accumulates at the water surface, producing a visible layer or colony.

Introduction

Purpose

This Action Plan is intended to provide the Wyoming Department of Environmental Quality (WDEQ), Wyoming Department of Health (WDH), Wyoming Livestock Board (WLB), resource management agencies and other cooperators with procedural guidelines should a harmful cyanobacterial bloom (HCB) be suspected in publicly accessible lakes or reservoirs in the State of Wyoming. Guidelines include: steps for evaluating whether a bloom is likely to contain harmful cyanobacteria; procedures to test for harmful levels of cyanobacteria and cyanotoxins; cyanobacteria cell density and cyanotoxin thresholds for issuing public health advisories; and procedures for lifting public health advisories. The plan also outlines the notification process should a HCB be identified in a public drinking water supply. Publicly accessible lakes and reservoirs used for primary contact recreation are the focus of this plan since contact, accidental ingestion and inhalation of cyanotoxins or other cyanobacteria-related irritants are most likely to occur in these waterbodies.

Background

HCBs are dense concentrations of cyanobacteria that have serious health consequences for humans, pets, and livestock through contact, ingestion, and/or inhalation of cyanotoxins or other cyanobacteria-related irritants. Other consequences of HCBs include: food web alterations and ecological dead zones (e.g., fish kills); ecotourism and property value losses; and negative impacts to drinking water supplies, agriculture and wildlife (Carmichael, 1992; Fawell et al., 1993; WHO, 1999). Cyanobacteria are commonly referred to as blue-green algae since they appear and function similar to algae, yet they are taxonomically distinct from true algae. As such, HCBs were previously referred to as *harmful algal blooms* or *HABs*.

Under normal conditions, cyanobacteria are present in the water column at low levels. When blooms occur, cyanobacteria become visibly abundant, typically forming dense colonies on the water surface (i.e., scums) and generally making the water green to bluish-green in appearance. Other cyanobacteria blooms may occur deeper in the water column (e.g., *Planktothrix rubescens*), may appear brownish-green like turbid water (e.g., *Cylindrospermopsis* spp.) or may attach to rocks, sediment or plants on bottom of a water body (e.g., benthic cyanobacteria such as *Phormidium* spp.) (USGS, 2008).

Cyanotoxins produced by cyanobacteria generally affect the body through three exposure pathways: the central nervous system, digestive system and renal system through ingestion; the respiratory system through inhalation; and the skin, eyes, nose, mouth and throat through contact. Health effects of toxin exposure may include nausea, fatigue, shortness of breath, coughing, disorientation, rashes, blisters, itching, numbness, burning, headache, fever, abdominal pain, vomiting, diarrhea, pneumonia, inflammation of the liver and impaired kidney function. Effects may occur within minutes to days after exposure. In extreme cases, cyanotoxins may lead to pet or livestock death. Currently, there are no known antidotes for cyanotoxins (Carmichael, 1992; Fawell et al., 1993; WHO, 1999). Health effects may also be linked to cyanobacteria cells and associated irritants, though these sources and their mode of action remain unclear (USEPA 2019).

The type of cyanotoxins present in a water body depends on the species/genera of cyanobacteria, though some species/genera are capable of producing multiple types of toxins. Moreover, toxigenic cyanobacteria, or those with genes that allow for cyanotoxin production, may only produce cyanotoxins under certain

environmental conditions. Toxigenic cyanobacteria that dominate blooms in Wyoming’s publicly accessible reservoirs and the cyanotoxins they produce are listed in Table C. These cyanotoxins are categorized by their primary mode of action: dermatotoxins (i.e., skin irritants), hepatotoxins (i.e., affect liver function), and neurotoxins (i.e., affect central nervous system). Sampling in Wyoming currently targets four cyanotoxins: microcystins, cylindrospermopsin, anatoxin-a and saxitoxin. These cyanotoxins are the most common cyanotoxins and have the most available information regarding their health effects.

Table C. Common cyanobacteria in Wyoming lakes and reservoirs and their associated cyanotoxins.

Cyanobacteria Genera	Dermatotoxins			Hepatotoxins			Neurotoxins			
	APL	LPS	LYN	CYL	MC	NOD	ATX	BMAA	NEO	SAX
<i>Anabaena</i> *		X		X	X		X	X	X	X
<i>Aphanizomenon</i>		X		X	X		X	X	X	X
<i>Aphanocapsa</i>		X			X					
<i>Cylindrospermopsis</i>		X		X			X			X
<i>Gloeotrichia</i>		X			X					
<i>Lyngbya</i>	X	X	X	X				X		X
<i>Microcystis</i>		X			X		X	X		
<i>Nodularia</i>		X				X		X		
<i>Phormidium</i>		X					X			
<i>Planktolyngbya</i>		X								
<i>Pseudanabaena</i>		X			X					

Data provided in this table are largely based on results documented in USGS (2008), WHO (1999), EPA website.

Toxin abbreviations are as follows: APL, aplysiatoxins; LPS, lipopolysaccharides; LYN, lyngbyatoxin-a; CYL, cylindrospermopsins; MC, microcystins; NOD, nodularins; ATX, anatoxins; BMAA, β-N-methylamino-L-alanine; NEO, neosaxitoxins; SAX, saxitoxins.

**Anabaena* is also known as *Dolichospermum*.

When released from cyanobacteria cells, cyanotoxins are colorless and may remain in the water column after a bloom has dissipated. Studies have shown cyanotoxins persisting anywhere from five days to several months in water and up to six months in dry scum (USEPA 2019). The rate at which cyanotoxins are removed depends on environmental factors such as water pH and temperature, ultraviolet degradation, the presence of particulate matter, water depth and bacterial breakdown (USGS 2008, USEPA 2019). Studies have also shown that certain strains of microcystin can remain in sediments for months or, conversely, bypass sediments and enter groundwater. Cyanotoxins and cyanobacteria can also flow downstream from lakes and reservoirs for indeterminate long distances (USEPA 2019).

Many factors including excess nutrients, sunlight, wind, flow and temperature contribute to the formation of HCBs. Although blooms can occur at any time, they are more likely to occur in late summer and early fall when reservoir temperatures warm, water levels stabilize, nutrients are assimilated, and phytoplankton productivity increases. Blooms may occur in some reservoirs following turn-over when nutrients are released from the bottom of a reservoir as cooler water is brought toward the surface. Shallow reservoirs, those with long residence times, or those with elevated concentrations of nutrients have an increased likelihood of blooms.

Action Levels

A critical objective of this plan is to identify cyanobacteria and cyanotoxin thresholds above which the WDH will issue a recreational use advisory to inform the public that they may encounter an HCB in a lake or reservoir and should avoid engaging in swimming or similar water contact activities near a bloom since

contact, accidental ingestion and inhalation of cyanotoxins or other HCB-related irritants are a potential health risk. The plan uses cyanobacteria cell density and ambient concentrations of the cyanotoxins microcystin and cylindrospermopsin, as these are currently the most reliable methods of determining potential health risks.

The cyanotoxin and cyanobacteria thresholds apply to the primary contact recreation season (i.e., May 1st through September 30th). This period represents the time when surface water and air temperatures in Wyoming are conducive to swimming and similar water contact activities, and therefore is when HCBs pose the greatest risk to public health via accidental ingestion, inhalation or direct contact with cyanotoxins and cyanobacteria-related irritants. Although HCBs may persist beyond the primary contact recreation season, the public health risks associated with the blooms are diminished due to the fact that cooler weather is likely to reduce the use of surface waters for swimming and similar water contact activities.

Because the extent of an HCB may change rapidly or may move from one area of a reservoir to another, WDH will issue a recreational use advisory for an entire reservoir unless otherwise noted. An advisory for a lake or reservoir should not, however, be interpreted as a lake closure since many areas of waterbody may not be impacted by an HCB.

Cyanotoxin Thresholds

In May 2019, the US Environmental Protection Agency (EPA) released [Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin](#) that states can consider for inclusion as water quality criteria for the protection of primary contact recreation and/or for issuing public health advisories. The recommended cyanotoxin thresholds are **8 µg/L total microcystins** and **15 µg/L cylindrospermopsin**. These recommendations are based on incidental ingestion by children while swimming since children represent the most vulnerable age group due to their extended periods of water play as well as the quantity of water they ingest. The recommendations were derived from peer-reviewed scientific literature and criteria methodologies in EPA's Exposure Factors Handbook. Thresholds were only developed for microcystin and cylindrospermopsin since they have the most available toxicological data, i.e., EPA has not released recommended criteria for any other cyanotoxins. It is important to note that these values may not be appropriate for domestic animals or livestock.

Cyanobacteria Thresholds

This plan also identifies potentially harmful densities of cyanobacteria since all cyanobacteria do not produce microcystin and cylindrospermopsin, there may be risks associated with direct contact to cyanobacteria cells (USEPA 2019) and cyanobacteria may transition from not producing cyanotoxins to producing cyanotoxins. Research also continues to suggest that cyanobacteria are highly diverse and capable of producing different toxins at different times, some of which may not be documented (Otten and Paerl 2015). For these reasons, Wyoming thresholds also include a **20,000 cells/mL cyanobacteria** cell density component. The cell density threshold was selected after reviewing scientific studies utilized by other state agencies and health organizations (Graham et al., 2009; Farrer et al., 2015). The cell density threshold is consistent with World Health Organization (WHO 1999) guidelines and represents the level at which acute health effects transition from low to moderate risk (Table D).

Table D. World Health Organization guidelines for cyanobacterial bloom characterization.

Acute Health Effects	Cyanobacteria (cells/mL)
Low	< 20,000
Moderate	20,000 to 100,000
High	100,000 to 10,000,000
Very High	> 10,000,000

*Microcystin-LR is commonly used to represent microcystin congeners due to widely available data and known toxicity

Additional Thresholds

In circumstances where a cyanobacterial bloom poses a potential health risk due to cyanotoxins other than microcystin and cylindrospermopsin (e.g., anatoxin-a, saxitoxin), WDH will determine an appropriate threshold for issuing an advisory, if necessary. WDH may also issue advisories based on other bloom conditions that pose health risks to people such as pet or livestock deaths. Thresholds included in this plan will be updated as more cyanobacteria and toxin data are collected in Wyoming's publicly accessible lakes and reservoirs and new scientific information becomes available.

Lake and reservoir CLOSURES do not have an established cyanobacteria or cyanotoxin threshold. According to Wyoming Statute (WS) § 35-1-240, WDH may issue a public beach or water body CLOSURE at any step of the process based on the threat to public health. Actual or potential cyanotoxin and cyanobacteria-related illnesses will be considered as part of this assessment. WDH will determine the location and extent of a CLOSURE by evaluating the threat to public health or where actual or potential cyanotoxin and cyanobacteria-related illnesses have been documented. WDH will follow usual processes and policies in place for mitigating public health threats, which may include notification of local officials, state agencies, the public, the media and healthcare providers.

Response Strategy

The response and monitoring strategies are based on four levels of evaluation: 1) observation and reporting; 2) optional preliminary screening; 3) sample collection, analysis and issuing advisories; and 4) monitoring and lifting advisories (see Table A).

Step 1: Observation and Reporting

WDEQ, WDH and WLB will issue a press release at the beginning of the HCB season to remind the public of the upcoming season, the health risks associated with HCBs, and how to identify and report HCBs.

HCBs may appear blue, green, yellow, white and/or brown in color and look like scums, clumps, floating mats, small grass clippings and/or spilled paint (USGS, 2008). These accumulations may be present at the water surface, evenly throughout the water column, at specific depths within the water column, attached to aquatic plants, or attached to the bottom of a water body. See WyoHCBs.org for photographs of cyanobacterial blooms in Wyoming. A helpful US Geological Survey Field and Laboratory Guide for identifying toxin-producing cyanobacteria is provided at the following link:

<https://pubs.er.usgs.gov/publication/ofr20151164>.

Water bodies with heavy recreational use, particularly those with swimming beaches or those that are frequently used for swimming and similar water contact activities, should be visually inspected

approximately weekly during the primary contact recreation season. Visual inspection should generally occur through observations by resource management agencies (e.g., Wyoming State Parks, Historic Sites & Trails; National Park Service; Wyoming Game and Fish Department; United States Forest Service; Bureau of Land Management; Bureau of Reclamation; United States Fish and Wildlife Service) as well as WDEQ, municipalities, and other cooperators. Observations of potential HCBs will also rely on public reporting by recreational users. Overall, management agencies and other cooperators are encouraged to work with WDEQ, WDH and WLB to educate staff, recreationalists and agricultural producers of cyanobacterial blooms, their potential health risks, and how to report suspected HCBs.

Resource constraints may limit the number of lakes and reservoirs that can be inspected by resource management agencies on a routine basis and the public may not consistently report suspected blooms. As such, WDEQ will use [Cyanobacteria Assessment Network](#) (CyAN) satellite imagery that detects HCBs due to the unique spectral signature of cyanobacteria. For lakes and reservoirs to be considered resolvable by CyAN, they must meet a minimum size requirement (>900 meters); this results in 40 lakes and reservoirs that can be monitored remotely by WDEQ. WDEQ will analyze imagery for these water bodies using screening metrics that determine the areal extent of blooms, cyanobacteria cell density and bloom persistence over time. WDEQ may also use CyAN imagery and other remote sensing platforms to determine if smaller lakes and reservoirs should be investigated.

A table of some publicly accessible recreational lakes and reservoirs is included in the resources section of the [WyoHCBs.org](#) webpage. The table details which water bodies are resolvable by CyAN and also contains recreational activities for lakes or reservoirs, the name and contact number of the entity that manages the water body, whether cyanobacterial blooms have been documented in the reservoir, and whether drinking water intakes are located in or downstream of the water body. This table serves as an information source should a suspected HCB occur in one of these lakes or reservoirs and should not be considered comprehensive. WDEQ and resource management agencies will likely prioritize some of these reservoirs for observation and monitoring based on historic cyanobacteria densities as well as water body use. The table will be updated periodically as new information becomes available.

In the event of a suspected HCB, observers should immediately report to WDEQ using the *Report a Spill* hotline at [WyoSpills.org](#) or call 307-777-7501. If reporting online, observers are encouraged to provide contact information and photographs of suspected blooms so WDEQ may contact complainants and conduct a preliminary evaluation. It is recommended that observers avoid contact with blooms until they are deemed safe. If observers believe that they may be experiencing adverse health effects after contact with a bloom, they should contact a health care provider or the Wyoming Poison Control Center at 1-800-222-1222. General information on HCB health risks can be found at: <https://www.cdc.gov/habs/>.

Step 2: Optional Preliminary Screening

Field tests are optional but may provide preliminary information on the potential health risks of a suspected HCB as well as the type of laboratory analysis that should be conducted. Once reported to WDEQ, suspected HCBs can be evaluated by WDEQ or a cooperator using jar and/or stick tests to determine whether cyanobacteria are present (see resources at [WyoHCBs.org](#) for procedure). WDEQ or a cooperator can also use field test strips (e.g., Abraxis Strip Test®) to test for cyanotoxins such as microcystins. Samplers should follow test strip protocols provided in their purchased test kit.

Samples for optional screening tests should be collected from the densest portion of a bloom in areas where the public comes into contact with the water (e.g., boat ramps, swimming beaches, etc.). If tests indicate that cyanobacteria or cyanotoxins are present and a permanent HCB sign is not already in place, the resource management agency may choose to post a temporary HCB sign to inform recreationalists of potential health risks. The HCB sign may also be posted prior to screening if the reservoir has a history of reoccurring HCBs or the bloom shows signs of worsening. HCB signage can be found at WyoHCBs.org and should be posted at heavily-used locations around the lake or reservoir. More information regarding permanent signs can be found in the next section.

Step 3: Sample Collection, Analysis and Issuing Advisories

If observations or preliminary screening suggest that a bloom may be harmful, WDEQ or a cooperator should collect four samples for laboratory analysis: one sample for cyanobacteria identification and enumeration; one sample for microcystin and cylindrospermopsin analysis; one sample for anatoxin-a analysis; and one sample for saxitoxin analysis. Similar to optional screening tests, samples should be collected from the densest portion of a bloom in areas where the public comes into contact with the water. Additional information on sampling protocols can be found in WDEQ's Standard Operating Procedures, *Harmful Cyanobacterial Blooms: Cyanobacteria Collection (Lentic)* and *Harmful Cyanobacterial Blooms: Cyanotoxin Collection (Lentic)* (see WyoHCBs.org). Samplers should follow all health and safety procedures included in these documents.

Cyanobacteria samples will be shipped to WDEQ's contract laboratory for cyanobacteria identification and enumeration. WDEQ will send cyanotoxin samples to the State of Wyoming Water Quality Lab in Cheyenne, Wyoming, for analysis using enzyme-linked immunosorbent assay (ELISA). WDEQ does not provide analytical support for private water bodies. If other entities are interested in having samples analyzed, a list of common laboratories that analyze cyanobacteria and cyanotoxins can be found on EPA's website: <https://www.epa.gov/cyanohabs/laboratories-analyze-cyanobacteria-and-cyanotoxins>.

If analyses reveal cyanobacteria density to meet or exceed the **20,000 cells/mL** threshold or total microcystin and cylindrospermopsin levels to meet or exceed the **8 µg/L** and **15 µg/L** threshold, respectively, WDEQ will notify WDH and WDH will issue an advisory for the lake or reservoir. If any cyanotoxins other than microcystin and cylindrospermopsin are detected (e.g., anatoxin-a and saxitoxin), or any other conditions such as human or animal illnesses are linked to the bloom, WDH will determine whether to issue an advisory.

Following issuance of an advisory, WDH will inform the resource management agency. WDH will also notify local health authorities and provide information on common cyanobacteria and cyanotoxin-related symptoms. If a drinking water intake is located on or downstream of the lake or reservoir, WDEQ will notify public water supplies as well as EPA, who implements the Safe Drinking Water Act in the State of Wyoming. WDEQ will also notify local county coordinators so the appropriate action can be taken in their respective county. Because of potential HCB-related impacts to migratory birds, eagles, fisheries and other wildlife, WDEQ will notify the U.S. Fish and Wildlife Service (USFWS) and the Wyoming Game and Fish Department (WGFD) once an advisory is issued. Notifications will be sent through the Wyoming HCB listserv. All past and current advisories will be posted on WDEQ's webmap at WyoHCBs.org. WDEQ encourages cooperators and recreationalists to visit the webpage for the most up-to-date information.

Once an advisory has been issued, WDEQ, WDH, WLB, resource management agencies, local county coordinators and cooperators should coordinate to establish: points of contact for each agency; signage modifications and placement at the lake or reservoir; a monitoring strategy; and a plan for disseminating monitoring results. WyoHCBs.org includes an example press release with health effects language and use restrictions. Press releases should not be used without approval from each agency's public information officer or communication coordinator.

WDH and WDEQ will notify health and water quality agencies of adjacent states and/or tribes when an advisory or closure has been issued for a publicly accessible lake or reservoir that occurs both in the State of Wyoming and in the adjacent state or tribal territory.

Permanent signs with advice on how to identify HCBs and avoid potential health risks, and inform the public to visit WyoHCBs.org for additional information, may already be installed at some reservoirs. If permanent HCB signs are not already in place or additional signs are warranted, WDH will coordinate posting of temporary signage by resource management agencies, local health authorities and/or local country coordinators. Permanent and temporary signs will utilize the same template that can be found at WyoHCBs.org. Signs should be posted around the entire waterbody since blooms may form, reform and move to different areas at any given time. Permanent and temporary signs should be posted at heavily trafficked locations, including boat ramps, swimming beaches, fee canisters, park entrances, etc., so they can be easily seen by recreationists.

Step 4: Monitoring and Lifting Advisories

Once an advisory has been issued, resource management agencies should continue to monitor the location, extent and severity of HCBs so that they can provide the most up to date information to recreationists. Resource management agencies should also ensure that any human illnesses or animal deaths have been reported to the WDH and continue to coordinate with public water supplies, if applicable. Resource management agencies are encouraged to coordinate with WDEQ if additional cyanobacteria or cyanotoxin samples are to be collected to monitor an ongoing HCB.

Advisories will remain in place until either (1) a bloom has fully dissipated **and** cyanotoxin concentrations are below the advisory thresholds or (2) the primary contact recreation season ends on September 30th. For an advisory to be lifted prior to September 30th, resource management agencies should provide visual evidence (e.g., photographs, video, etc.) to WDEQ that the bloom has fully dissipated. WDEQ will evaluate the evidence as well as satellite imagery provided by the CyAN, if available. If both the visual evidence and satellite imagery indicate that cyanobacteria are not present, WDEQ will conduct cyanotoxin sampling to confirm safe levels. Once confirmed, WDEQ will notify WDH and WDH will lift the advisory.

WDH will lift all remaining advisories still in place at the end of the primary recreation season on September 30th. At that time, WDH, WDEQ and WLB will issue a press release and listserv notice describing that (1) any remaining advisories have been lifted, (2) WDEQ is no longer monitoring for HCBs due to the end of the primary contact recreation season, (3) HCBs may continue to be present in Wyoming surface waters in the cooler months, and (4) recreationists, including waterfowl hunters and ice fisherman, should continue to avoid HCBs due to the potential health risks.

Once advisories have been lifted, WDH may coordinate the removal of any temporary signs by resource management agencies, local health authorities and/or local country coordinators. WDEQ will remove the lake or reservoir from the list of current advisories on the WyoHCBs.org webpage and notify the public via the Wyoming HCB listserv. Resource management agencies should continue to observe the waterbody and report new cyanobacterial blooms if they appear.

Public Outreach

The WDEQ, WDH, WLB and cooperating agencies should work to inform the public of the adverse health effects associated with HCBs and how to identify and report a suspected bloom. A HCB flyer, frequently asked questions (FAQs), photo gallery, webinar presentation and video for public dissemination can be found in the resources section of the WyoHCBs.org webpage. In the event of an advisory or closure, WDEQ, WDH, WLB and cooperating agencies should coordinate to ensure that information is disseminated via signs, press releases, videos, websites, social media, periodicals and other public forums.

Public Water Supplies

Due to the serious health effects of cyanobacteria and cyanotoxins, public water supply utilities with surface waters or groundwater under the influence of surface water will be notified by WDEQ when cyanobacterial blooms are suspected within or in close proximity to source waters. Specifically, public water supplies will be notified by WDEQ when cyanotoxin levels exceed the drinking water advisory levels (Table E). WDEQ will also notify EPA, who implements the Safe Drinking Water Act in the State of Wyoming, as well as the WDH. The children and adult advisory levels correspond with EPA's Ten-Day Health Advisories for microcystin and cylindrospermopsin and represent concentrations at which adverse health effects are anticipated (USEPA 2015a, USEPA 2015b).

Once notified, public water supplies, EPA, and WDH will determine appropriate next steps, including initiating their own sampling to ensure public safety (see EPA's drinking water response strategy on WyoHCBs.org) WDH may issue a Do Not Drink and Do Not Boil order when finished drinking water exceeds cyanotoxin thresholds. A Do Not Boil order is necessary since boiling will not remove cyanotoxins and may actually increase toxin levels by lysing cyanobacteria cells. These orders should not be lifted until sampling results indicate that cyanotoxins have fallen and will remain below the drinking water advisory thresholds.

Table E. Wyoming drinking water thresholds for cyanotoxin concentrations.

Threshold	Threshold Value	Responsive Action
Drinking Water	$\geq 0.3 \mu\text{g/L}$ Microcystin ¹ (children and vulnerable populations ²) $\geq 1.6 \mu\text{g/L}$ Microcystin ¹ (adults)	Do Not Drink / Do Not Boil
	$\geq 0.7 \mu\text{g/L}$ Cylindrospermopsin (children and vulnerable populations ²) $\geq 3.0 \mu\text{g/L}$ Cylindrospermopsin (adults)	

¹ Microcystin thresholds ($\mu\text{g/L}$) are to be applied to total concentrations of all congeners of those toxins.

² Vulnerable populations include pregnant women, nursing mothers, those with pre-existing liver conditions, those receiving dialysis treatment, the elderly and other sensitive populations.

Illness Reporting and Tracking

The WDH will report any individual human or animal cases of HCB-related illnesses using the [One Health Harmful Algal Bloom System](#) (OHHABS). This collaborative network between state and federal partners provides: electronic reporting by state and local health departments via the [National Outbreak Reporting System](#) (NORS); case studies of HCB-related illness surveillance; and support from the Great Lakes Restoration Initiative that uses OHHABS data to inform their restoration objectives. More information and resources can be found at the OHHABS website.

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